10/511128

FIG. 1

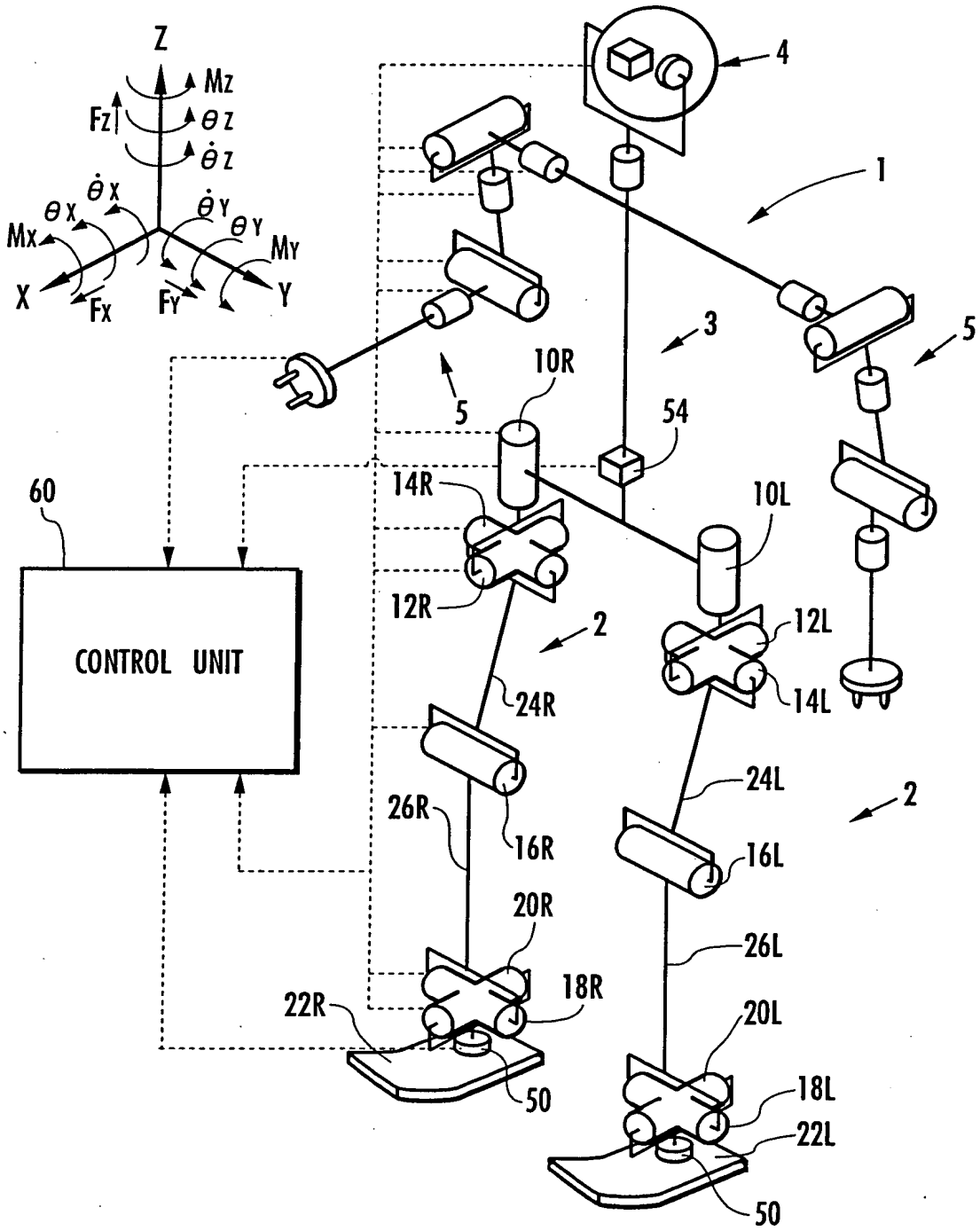


FIG. 2

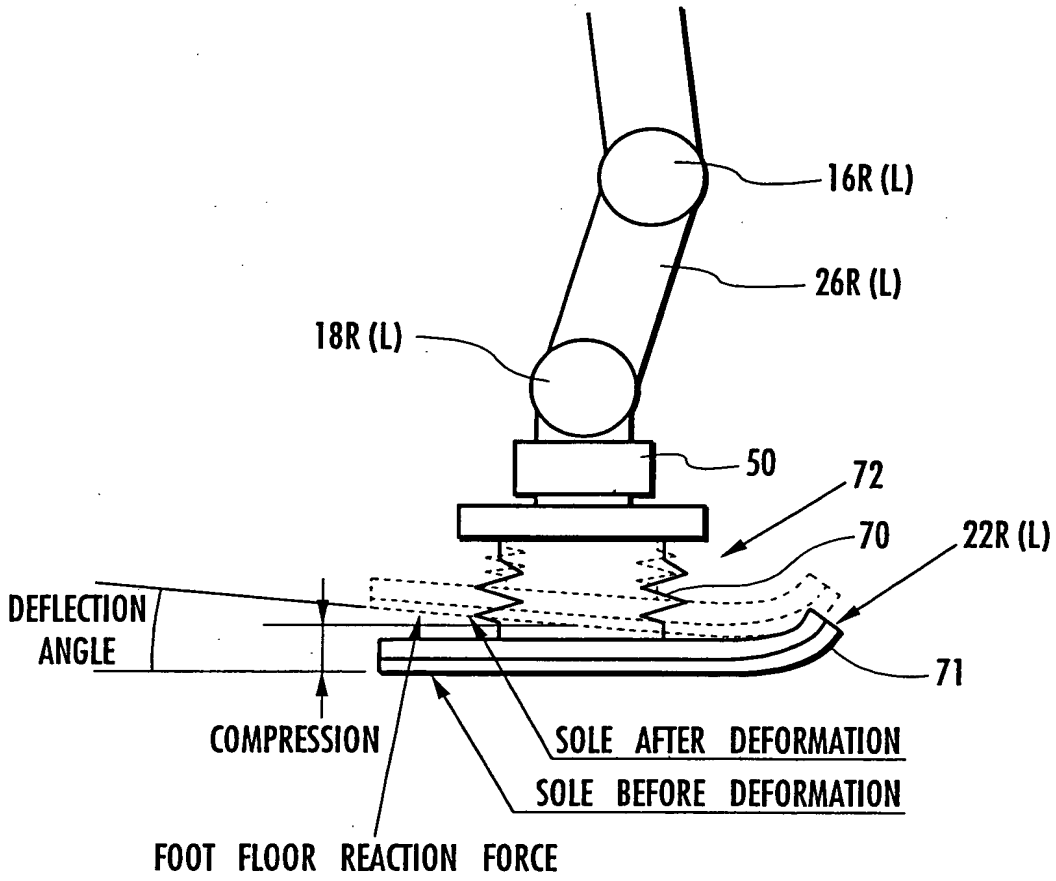

16R (L)
26R (L)
18R (L)
50
72
70
22R (L)
DEFLECTION ANGLE
71
COMPRESSION
SOLE AFTER DEFORMATION
SOLE BEFORE DEFORMATION
FOOT FLOOR REACTION FORCE

FIG. 3

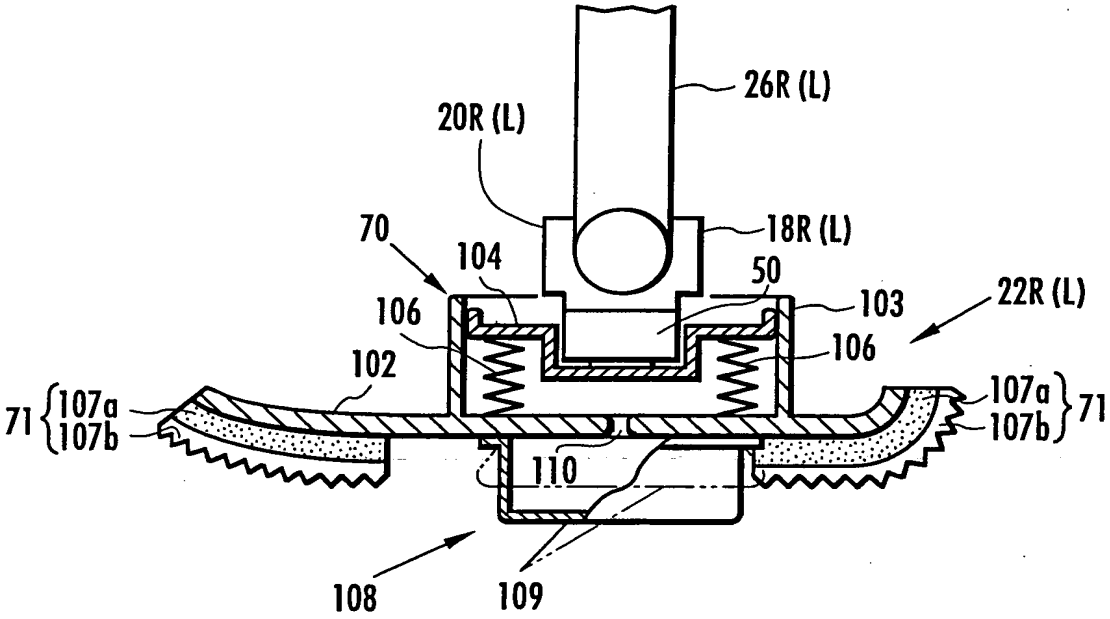

26R (L)
20R (L)
18R (L)
70
104
50
106
103
22R (L)
106
102
71
107a
107b
107a
107b
71
110
108
109

FIG. 4

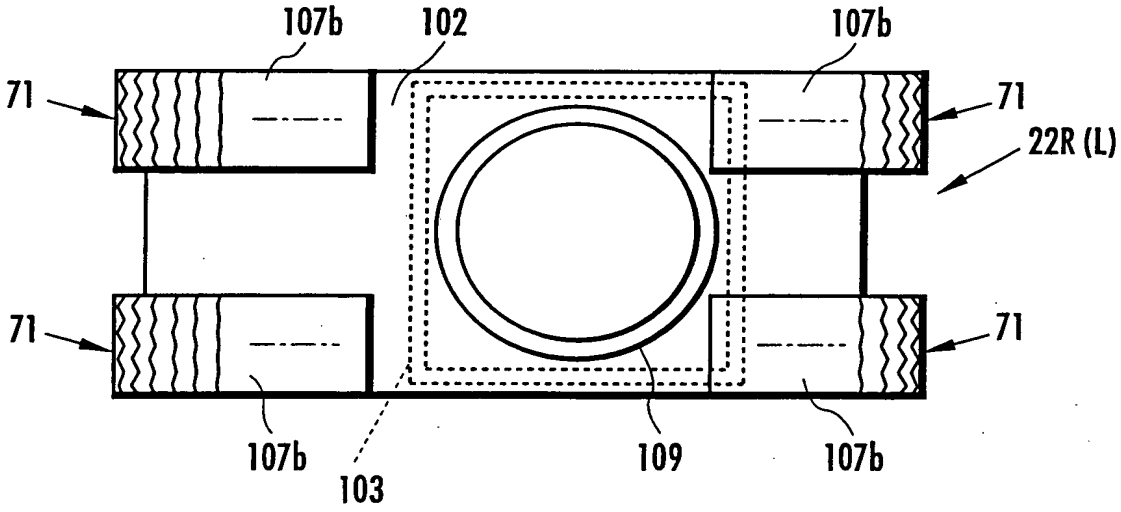

107b
102
107b
71
71
22R (L)
71
71
107b
103
109
107b

FIG. 5

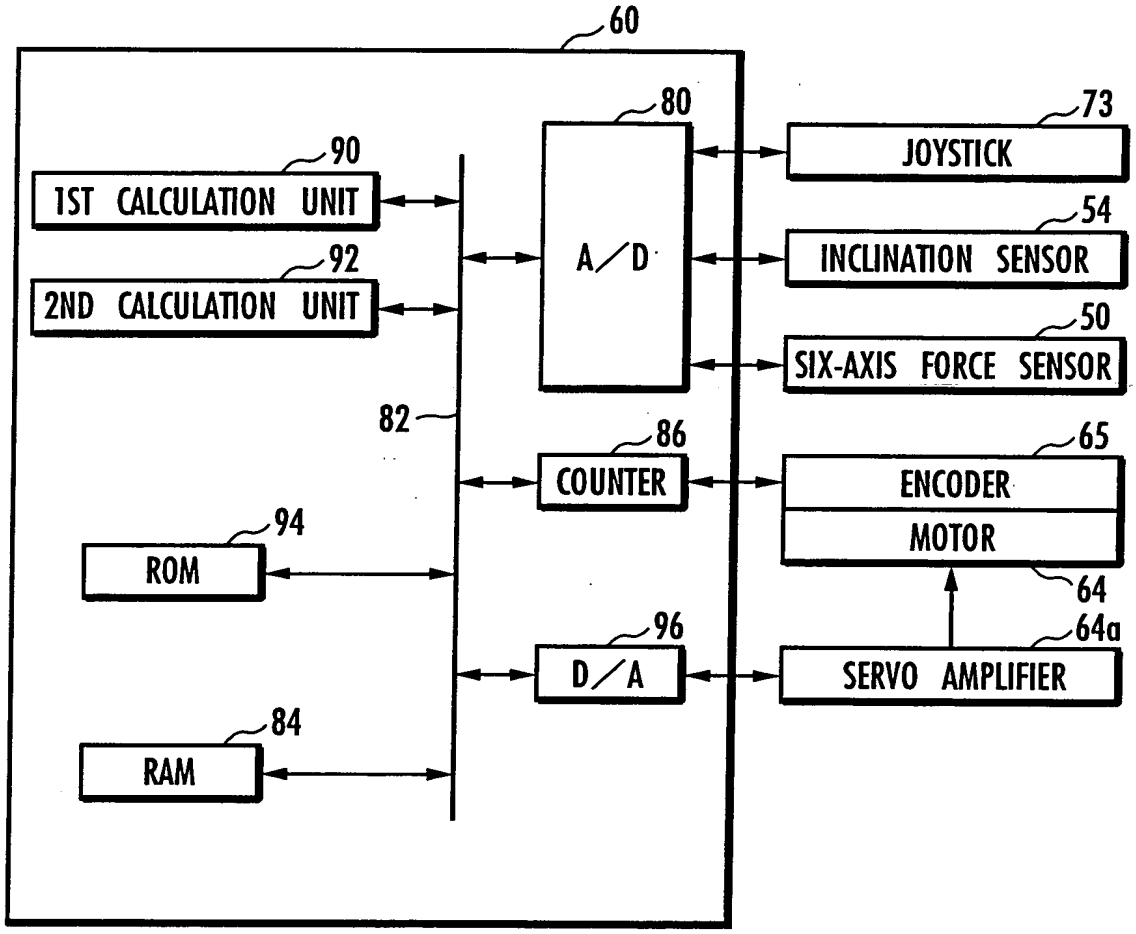


FIG.6

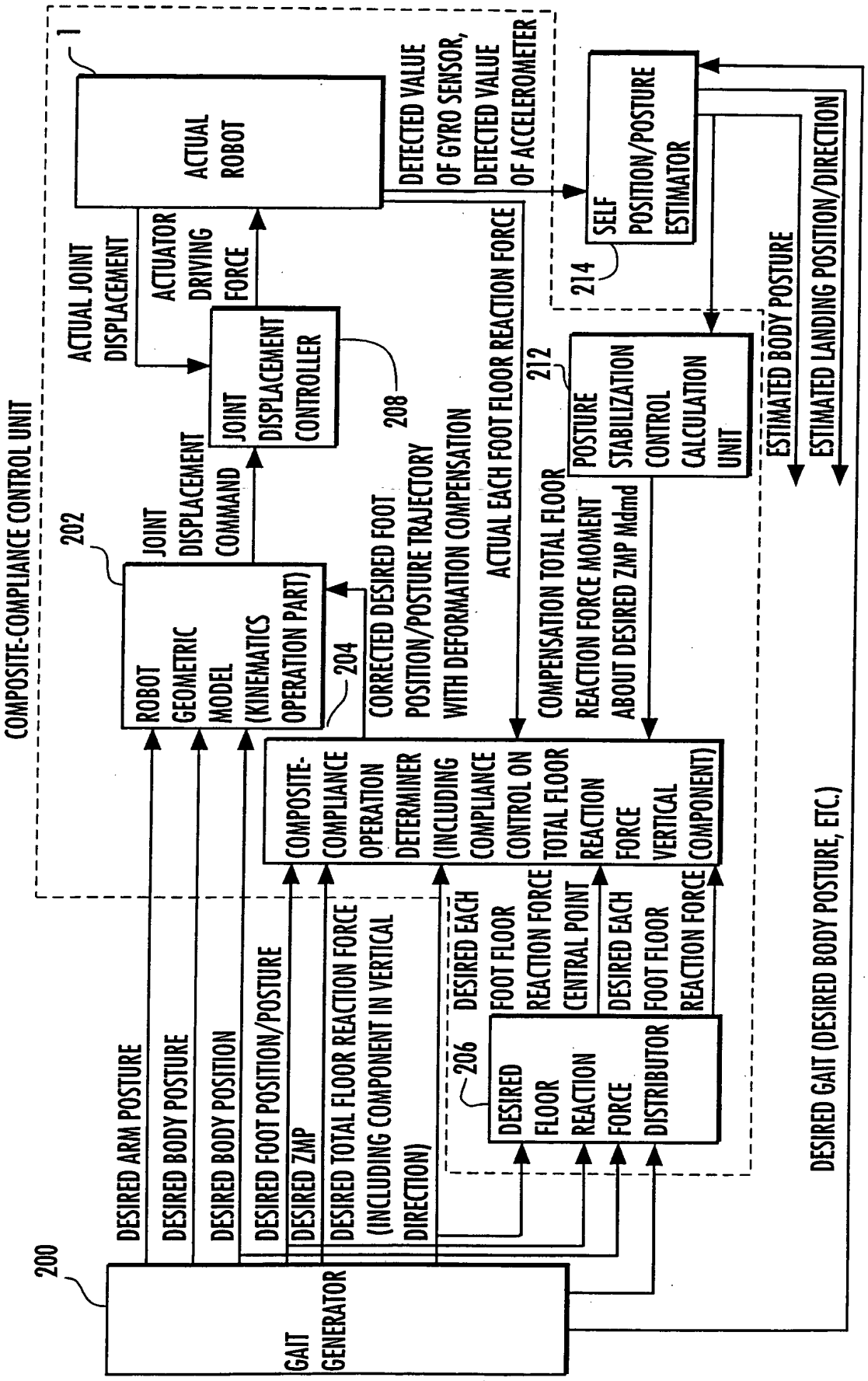

COMPOSITE-COMPLIANCE CONTROL UNIT
1
ACTUAL ROBOT
DETECTED VALUE OF GYRO SENSOR, DETECTED VALUE OF ACCELEROMETER
SELF POSITION/POSTURE ESTIMATOR
214
ACTUAL JOINT DISPLACEMENT
ACTUATOR DRIVING FORCE
JOINT DISPLACEMENT CONTROLLER
208
212
POSTURE STABILIZATION CONTROL CALCULATION UNIT
ESTIMATED BODY POSTURE
ESTIMATED LANDING POSITION/DIRECTION
202
JOINT DISPLACEMENT COMMAND
ROBOT GEOMETRIC MODEL (KINEMATICS OPERATION PART)
204
CORRECTED DESIRED FOOT POSITION/POSTURE TRAJECTORY WITH DEFORMATION COMPENSATION
ACTUAL EACH FOOT FLOOR REACTION FORCE
COMPENSATION TOTAL FLOOR REACTION FORCE MOMENT ABOUT DESIRED ZMP Mdmd
COMPOSITE-COMPLIANCE OPERATION DETERMINER (INCLUDING COMPLIANCE CONTROL ON TOTAL FLOOR REACTION FORCE VERTICAL COMPONENT)
DESIRED ARM POSTURE
DESIRED BODY POSTURE
DESIRED BODY POSITION
DESIRED FOOT POSITION/POSTURE
DESIRED ZMP
DESIRED TOTAL FLOOR REACTION FORCE (INCLUDING COMPONENT IN VERTICAL DIRECTION)
206
DESIRED EACH FOOT FLOOR REACTION FORCE CENTRAL POINT
DESIRED EACH FOOT FLOOR REACTION FORCE
DESIRED FLOOR REACTION FORCE DISTRIBUTOR
200
GAIT GENERATOR
DESIRED GAIT (DESIRED BODY POSTURE, ETC.)

FIG. 7

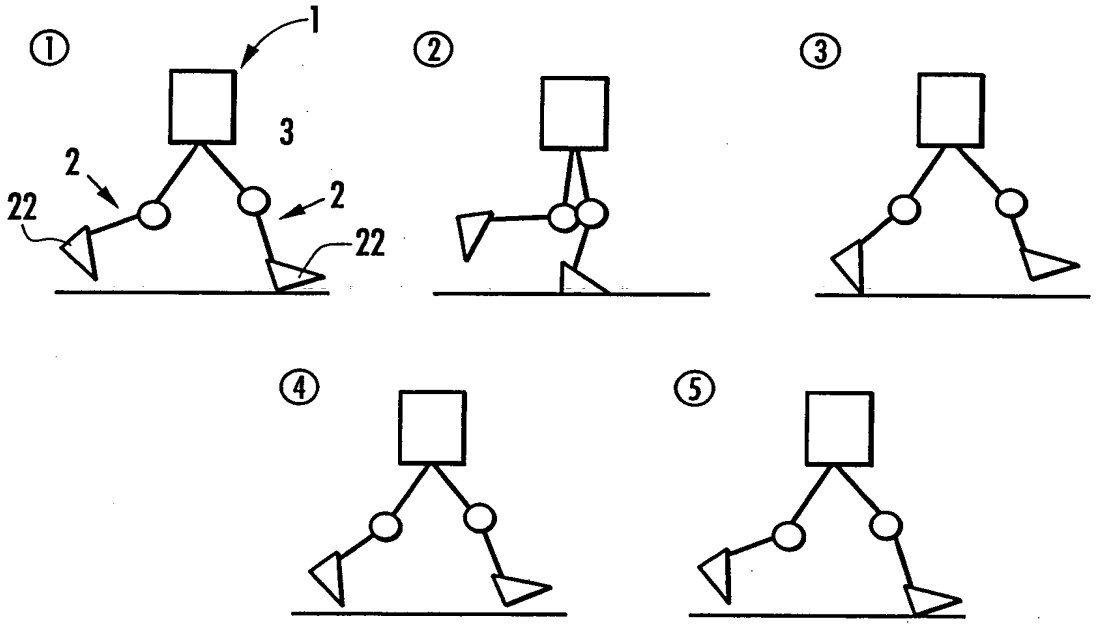


FIG.8 (a)

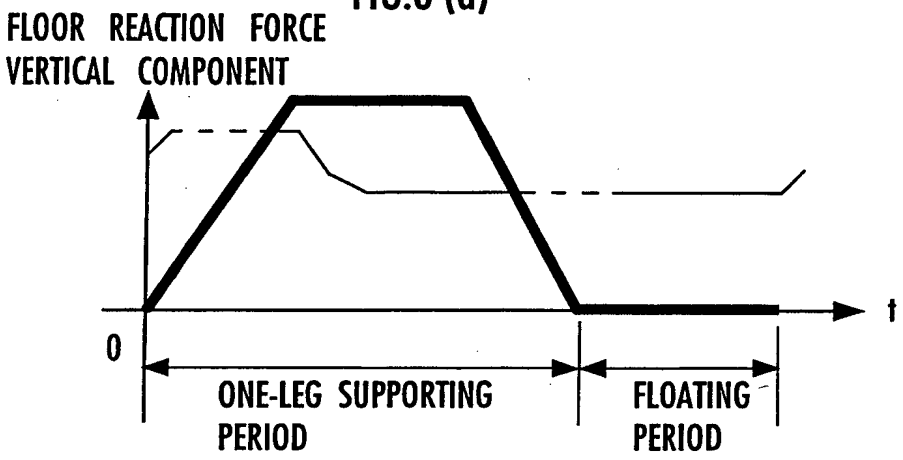


FIG.8 (b)

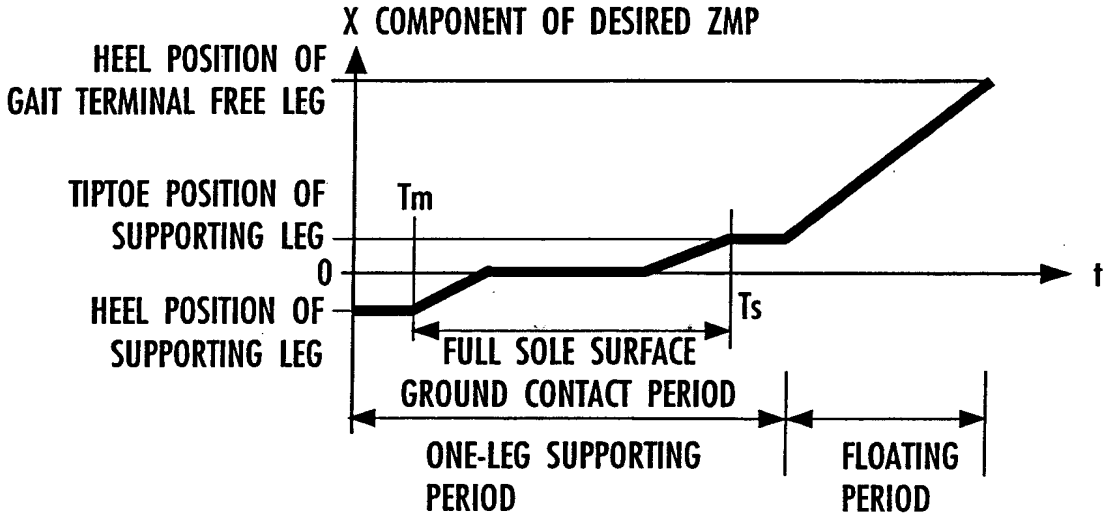


FIG.8 (c)

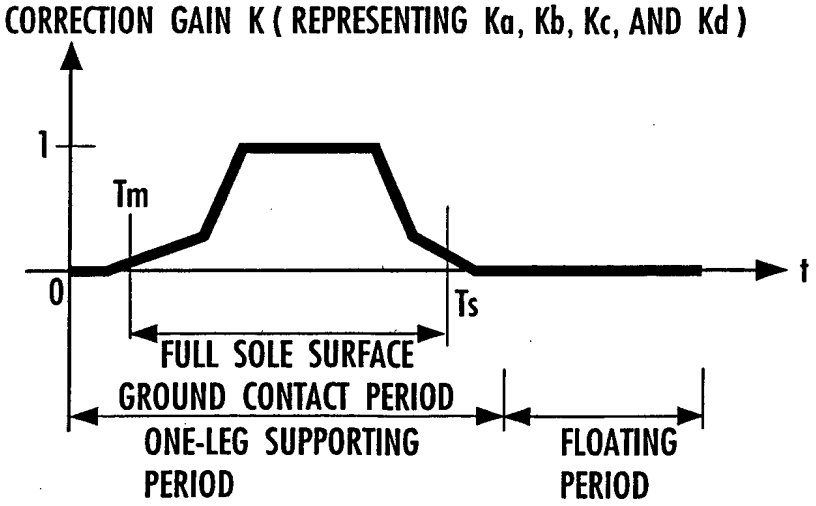
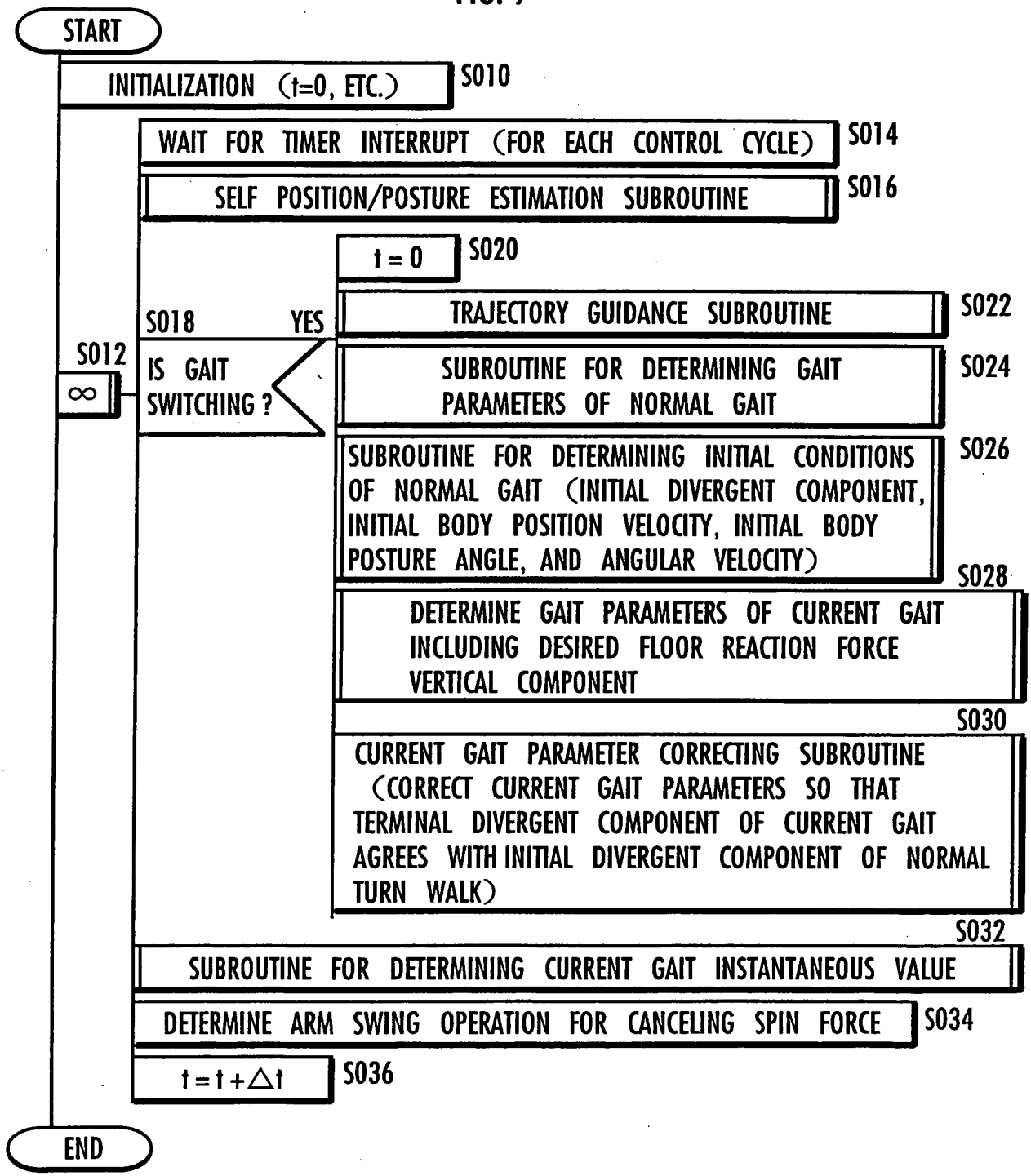


FIG. 9


START
INITIALIZATION (t=0, ETC.)
S010
WAIT FOR TIMER INTERRUPT (FOR EACH CONTROL CYCLE)
S014
SELF POSITION/POSTURE ESTIMATION SUBROUTINE
S016
t = 0
S020
S018
YES
TRAJECTORY GUIDANCE SUBROUTINE
S022
S012
∞
IS GAIT SWITCHING ?
SUBROUTINE FOR DETERMINING GAIT PARAMETERS OF NORMAL GAIT
S024
SUBROUTINE FOR DETERMINING INITIAL CONDITIONS OF NORMAL GAIT (INITIAL DIVERGENT COMPONENT, INITIAL BODY POSITION VELOCITY, INITIAL BODY POSTURE ANGLE, AND ANGULAR VELOCITY)
S026
S028
DETERMINE GAIT PARAMETERS OF CURRENT GAIT INCLUDING DESIRED FLOOR REACTION FORCE VERTICAL COMPONENT
S030
CURRENT GAIT PARAMETER CORRECTING SUBROUTINE (CORRECT CURRENT GAIT PARAMETERS SO THAT TERMINAL DIVERGENT COMPONENT OF CURRENT GAIT AGREES WITH INITIAL DIVERGENT COMPONENT OF NORMAL TURN WALK)
S032
SUBROUTINE FOR DETERMINING CURRENT GAIT INSTANTANEOUS VALUE
DETERMINE ARM SWING OPERATION FOR CANCELING SPIN FORCE
S034
t = t + △t
S036
END

10/511128

FIG. 10

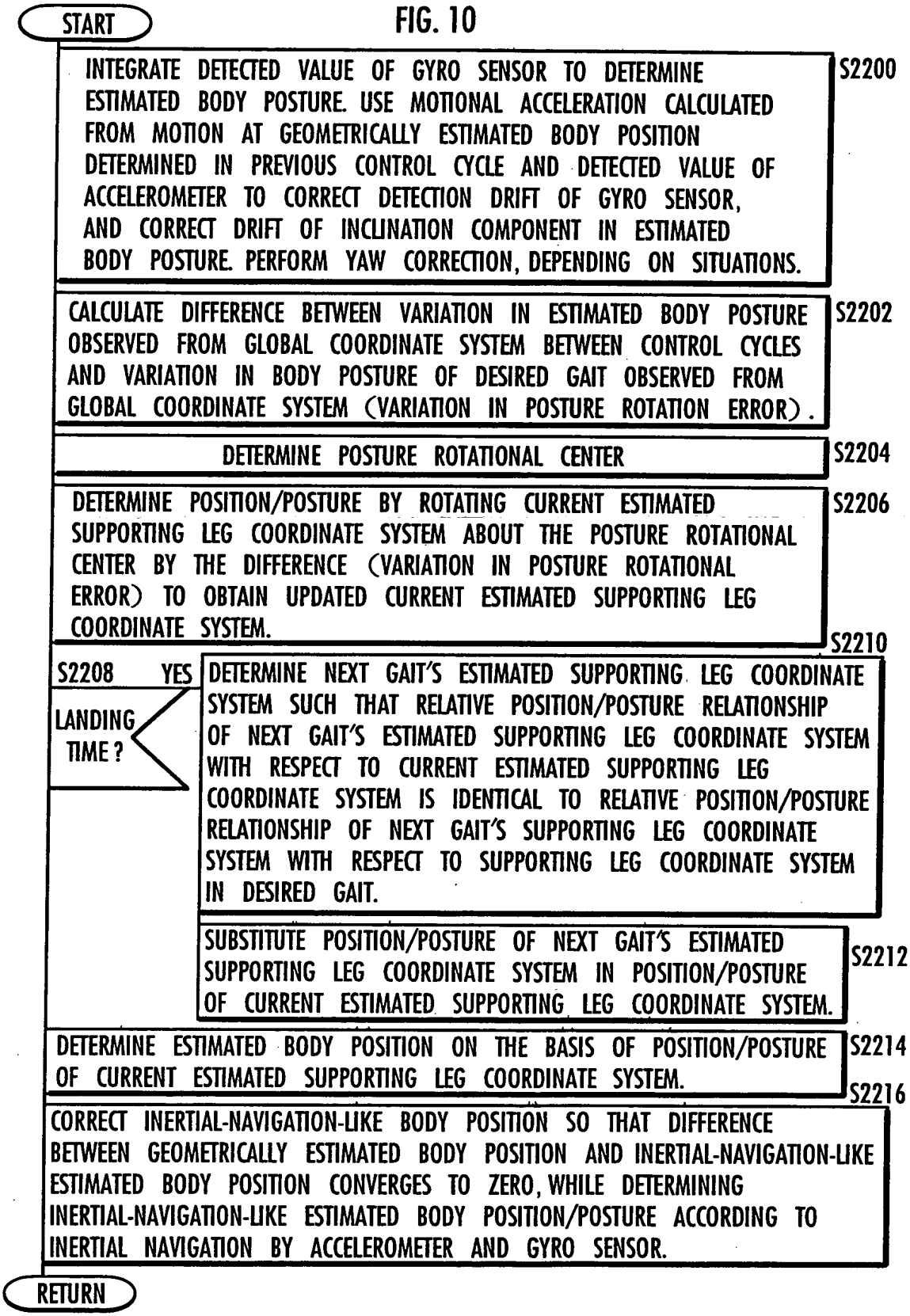


FIG. 11

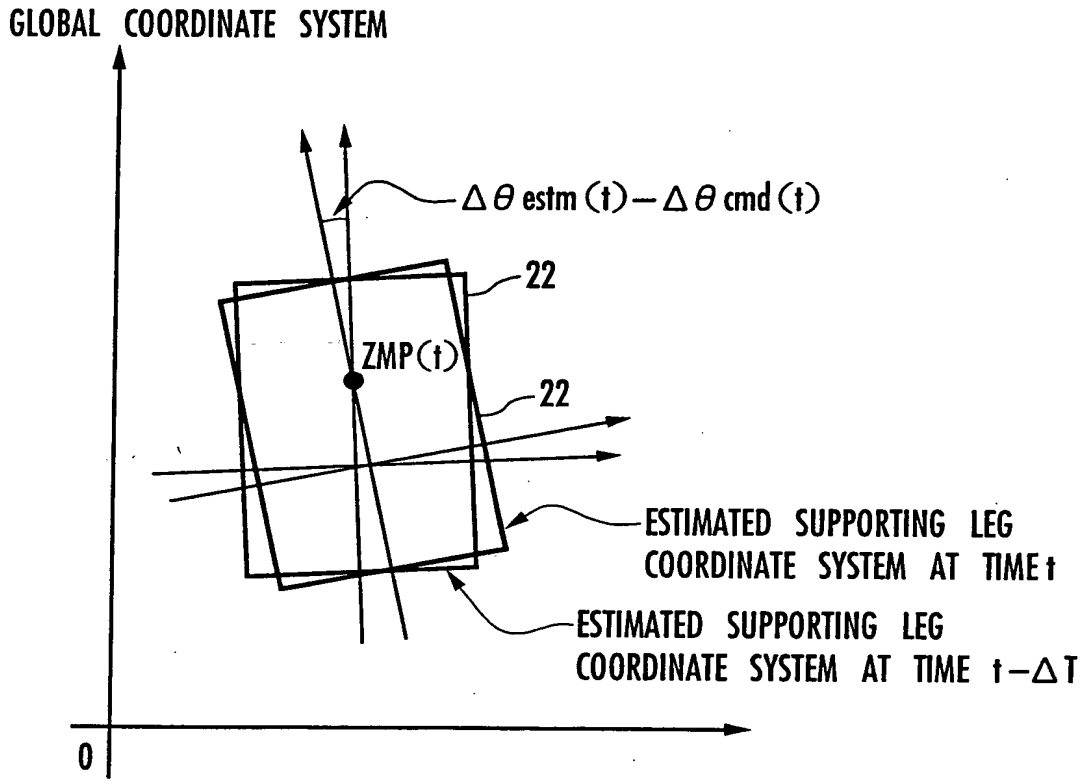

GLOBAL COORDINATE SYSTEM
Δθ estm (t) − Δθ cmd (t)
22
ZMP(t)
22
ESTIMATED SUPPORTING LEG COORDINATE SYSTEM AT TIME t
ESTIMATED SUPPORTING LEG COORDINATE SYSTEM AT TIME t−ΔT
0

FIG.12

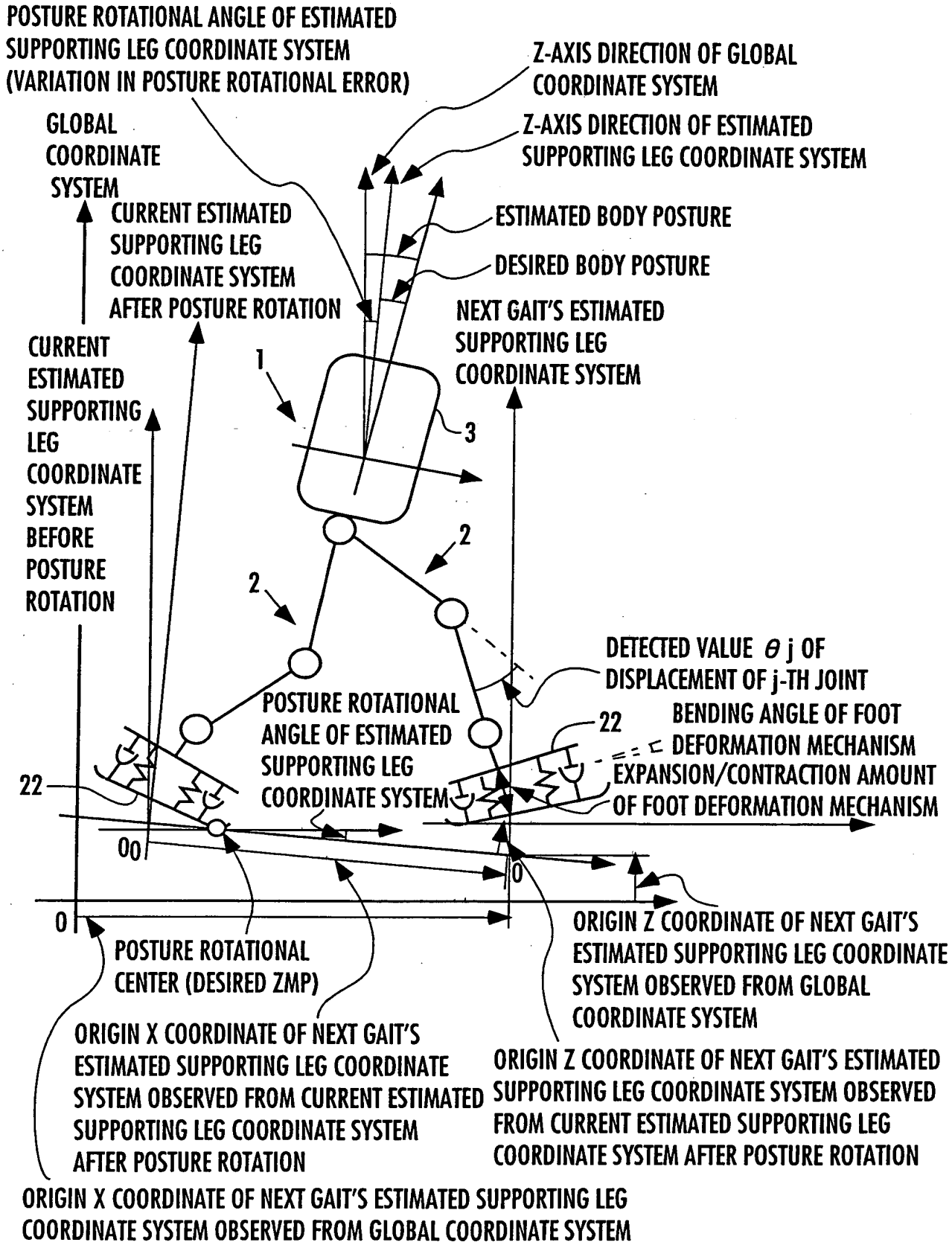
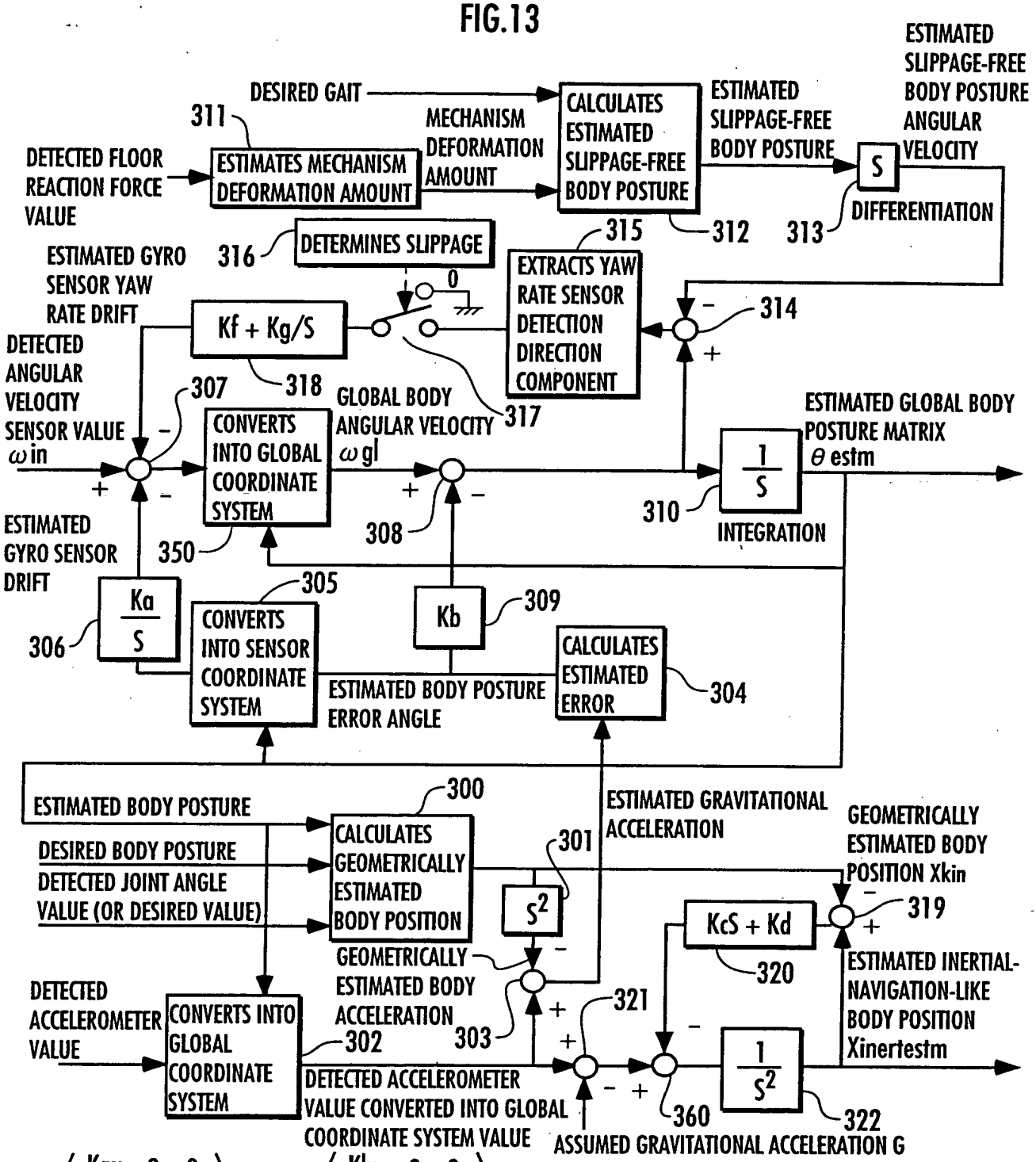

POSTURE ROTATIONAL ANGLE OF ESTIMATED SUPPORTING LEG COORDINATE SYSTEM (VARIATION IN POSTURE ROTATIONAL ERROR)
Z-AXIS DIRECTION OF GLOBAL COORDINATE SYSTEM
Z-AXIS DIRECTION OF ESTIMATED SUPPORTING LEG COORDINATE SYSTEM
GLOBAL COORDINATE SYSTEM
CURRENT ESTIMATED SUPPORTING LEG COORDINATE SYSTEM AFTER POSTURE ROTATION
ESTIMATED BODY POSTURE
DESIRED BODY POSTURE
NEXT GAIT'S ESTIMATED SUPPORTING LEG COORDINATE SYSTEM
CURRENT ESTIMATED SUPPORTING LEG COORDINATE SYSTEM BEFORE POSTURE ROTATION
1
2
2
3
DETECTED VALUE θj OF DISPLACEMENT OF j-TH JOINT
22
BENDING ANGLE OF FOOT DEFORMATION MECHANISM
EXPANSION/CONTRACTION AMOUNT OF FOOT DEFORMATION MECHANISM
POSTURE ROTATIONAL ANGLE OF ESTIMATED SUPPORTING LEG COORDINATE SYSTEM
22
00
0
0
POSTURE ROTATIONAL CENTER (DESIRED ZMP)
ORIGIN Z COORDINATE OF NEXT GAIT'S ESTIMATED SUPPORTING LEG COORDINATE SYSTEM OBSERVED FROM GLOBAL COORDINATE SYSTEM
ORIGIN X COORDINATE OF NEXT GAIT'S ESTIMATED SUPPORTING LEG COORDINATE SYSTEM OBSERVED FROM CURRENT ESTIMATED SUPPORTING LEG COORDINATE SYSTEM AFTER POSTURE ROTATION
ORIGIN Z COORDINATE OF NEXT GAIT'S ESTIMATED SUPPORTING LEG COORDINATE SYSTEM OBSERVED FROM CURRENT ESTIMATED SUPPORTING LEG COORDINATE SYSTEM AFTER POSTURE ROTATION
ORIGIN X COORDINATE OF NEXT GAIT'S ESTIMATED SUPPORTING LEG COORDINATE SYSTEM OBSERVED FROM GLOBAL COORDINATE SYSTEM

FIG.13



13 / 14

FIG.14 (a)

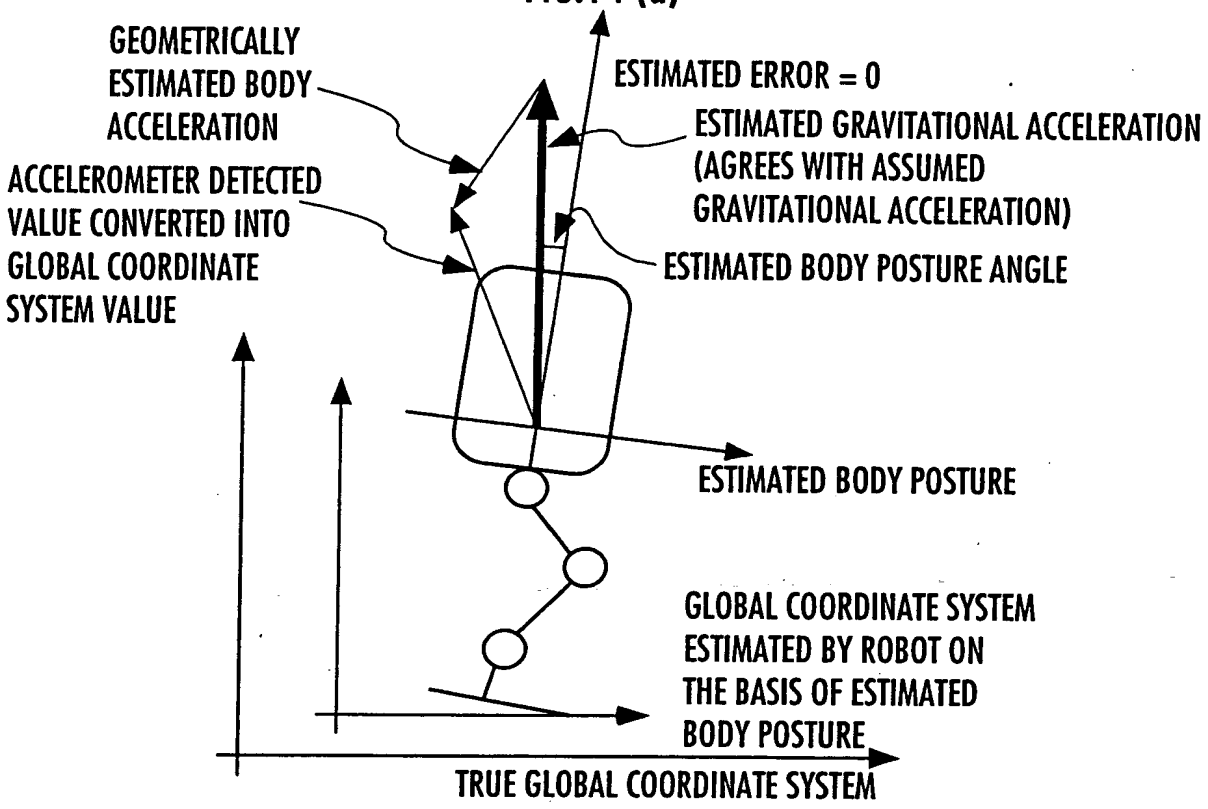


FIG.14 (b)

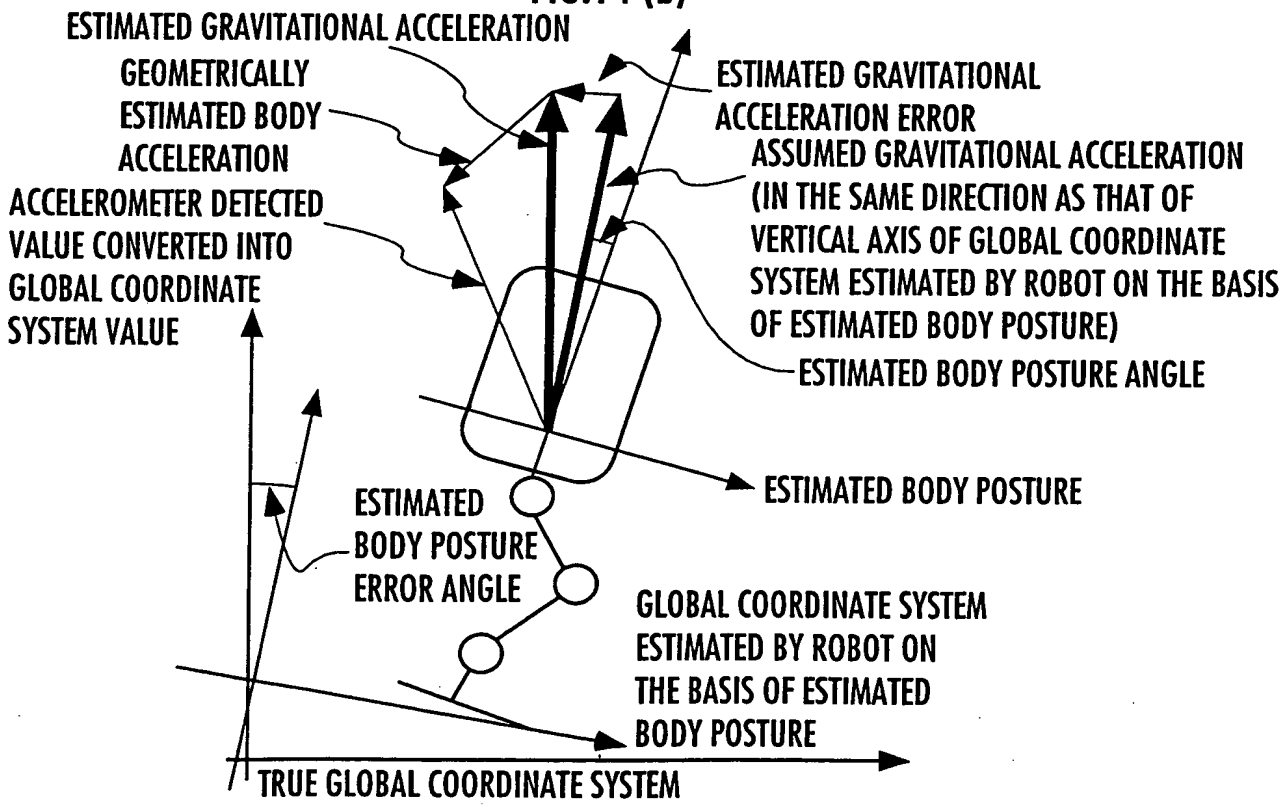


FIG. 15